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West Europe Report

SCIENCE AND TECHNOLOGY

No. 37

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COAL CONGRESS EXPLORES PROSPECTS FOR FLUIDIZED-BED SYSTEMS

Graefelfing ENERGIE in German Jun/Jul 80 pp 271-276

[Text] Introduction

> Fluidized bed firing is suitable, like hardly any other "Energy generating system" for linking the advantages of rational use of domestic energy carriers with needs for environmental protection. Operating experience with the pilot plants are very promising and commercial use is moving into the forseeable future.

The turmoil about the fluidized bed is not diminishing. The Federal Ministry for Research and Technology alone is promoting 13 projects with a total sum of DM 148 million. Two plants are already in operation, another four will come onstream in the FRG by 1982. All known boiler manufacturers are participating in the construction or planning of pilot plants. It has become the duty of turbine manufacturers--whether they be KWU, MAN or BBC--to adjust to fluidized bed firing (FBF) with new designs.

Two points make the firing system especially attractive:

--With quickly increasing environmental protection requirements, only fluidized bed firing is able to maintain strict emission limits without additional investments

--Even ballast coal can be fired in the fluidized bed.

Regardless of whether we are dealing with premium hard coal or ballast coal having only a breath of heating value, the "all-fuel" fluidized bed will supply steam, i.e. for heat and electricity, with a high efficiency level with little pollution emissions. Thus, the desire of industry for a firing system for inexpensive, highly available fuel can be met, in addition to the desire of many city fathers for a heating power plant in the city limits, without having to spend a lot of money for the otherwise required flue gas scrubber.

At the Coal Congress sponsored by Resch Publishers in February 1980, an extensive and detailed overview of the present status of fluidized bed technology in the FRG was offered. In the lectures and other presentations by manufacturers, engineering firms and operators, all previously erected and presently planned plants were described and operating experiences reported.

A subsequent podium discussion with the editors, under the leadership of Dr Dieter Schilling of Bergbauforschung, provided sufficient room for open questions to point up differences and answer questions of most interest to the participants: When and at what cost will FBF be ready for industrial use?

Pilot Plants for Fluidized-Bed Firing in the FRG

Number,	operator	Location	Plant size	Startup
1	Ruhrkohle AG	Recklinghausen	6 MW_{th}	1979
2	Ruhrkohle AG	Flingern	35 MW_{th}	1979
3	Ruhrkohle AG	Dortmund	35 MW_{th}	1980
4	Saarbergwerke	Volklingen	100 MW_{th}	1981
5	Elektrizitatswerke Wesertal	Afferde	125 MW_{th}	1982
6	Bergbau-Forschung Vereinigte Kesselwerke	Bottrop	25 MW_{th} at 5 bar pressure	1982

Background, Pilot Plants

Within the frame of presently operating--at least on a pilot scale--methods, there are three basic systems with appertinent boiler and processing equipment:

--"classical" atmospheric-pressure operated fluidized-bed firing

--atmospheric-pressure operated circulating (fast) fluidized-bed firing and

--supercharged (pressurized) fluidized-bed firing

The most widely used and best developed of these is doubtless the unpressurized, classical FBF, whose characteristics are today counted as "state of the art" (Figure 1).

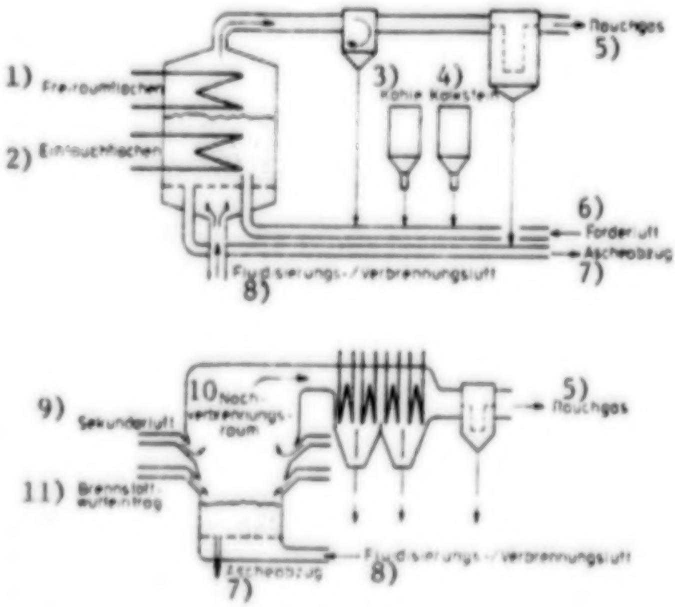

Figure 1: Design of Classical Fluidized-Bed Firing Systems

Key:

1. Open surfaces
2. Immersed surfaces
3. Coal
4. Limestone
5. Flue gas
6. Delivery air
7. Ash removal
8. Fluidization/combustion air
9. Secondary air
10. After-combustion chamber
11. Fuel inlet

The basically different fuel inlet philosophies are of primary interest?

On the one hand, base coal injection with the consequences of a relatively complex fuel inlet (as a rule, not without drying), but with good cross-sectional load (1.2 to 1.7 MW/m^2) and compact design through immersed heating surfaces in a classical fluidized bed--compared on the other hand to simple operation and inexpensive mound firing on a slightly fluidized moving bed with its consequences of lower throughput per cross section, worse desulfuring behavior and poorer burnoff.

An important advance is circulating fluidized-bed firing with greatly expanding fluidization, with secondary air injection for improved harmonization of flow-mechanical and fire-kinetic conditions and attendant need for permanent solids withdrawal (Figure 2).

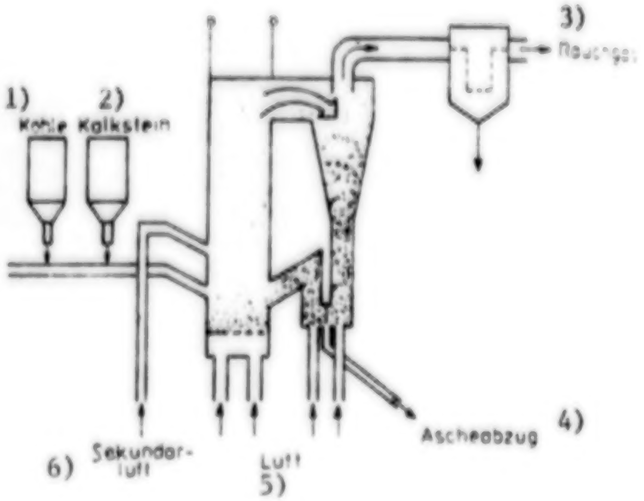

Figure 2: Design of a Circulating Fluidized Bed-Firing System

Key:
1. Coal
2. Limestone
3. Flue gas
4. Ash removal
5. Air
6. Secondary air

Attainable process improvements:

--two to four-fold throughput per cross section of reactor chamber

--further improved desulfurization behavior

--reduced NO$_x$ formation

--better burnoff

--omission of immersion heaters due to much better heat transfer to reactor wall

--better temperature control

--lower specific investment costs through smaller design volume.

Principle disadvantages are:

--need for a smaller coal and limestone grain

--need for a tighter grain size distribution

--gas/solid separation at high termperature range

--reduced operating costs only when operating at optimum desulfurization (operating cost advantage in spite of complex fuel processing).

It should be added that the circulating fluidized bed is known and proven in process industries (e.g. aluminum hydroxide calcination), but as a coal firing system with attendant boiler periphery, it has not yet gone beyond the planning and project phase.

The second, technically and economically no less interesting modern fluidized-bed system is the classical configuration using pressurized conditions (Figure 3).

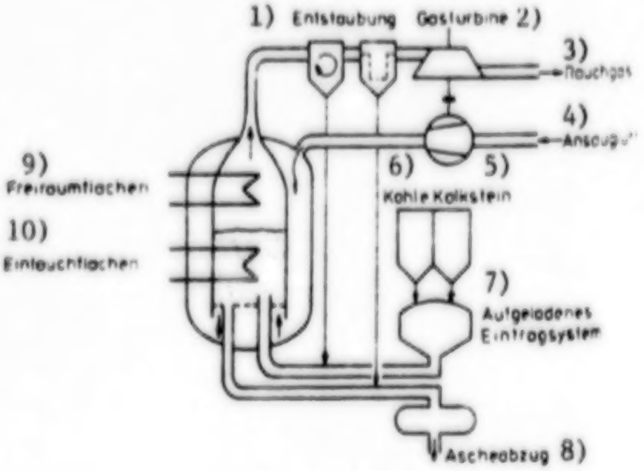

Figure 3: Design of the Pressurized Fluidized-Bed Energy Generation System

Key:
1. Dust removal
2. Gas turbine
3. Flue gas
4. Intake air
5. Limestone
6. Coal
7. Pressurized inlet system
8. Ash removal
9. Open surfaces
10. Immersed surfaces

As a rule, the thermal reactor stress is separate from the pressure stress due to double-dish construction. The pressurized-flue gases are relaxed in the flue gas turbine--after previous dust filtration steps--which can drive the compressor for compressed air supply to fluidization and combustion. This will occur with or without additional release of useful energy in the form of electricity. Coal introduction and ash removal are designed as pressurized systems. This is also an important process step, even with the same comparison basis.

Attainable process improvements are:

--significant increase in air/coal throughput per cross section with simultaneous reduction of air speed causing: considerable reduction in design volume (depending on pressure level), improved burnoff (even without material feedback), improved desulfurization behavior.

--possibility of combining gas turbines with steam turbines with overall improved efficiency

--at higher outputs and pressures, reduction in specific investment costs through reduction in construction size and higher degree of prefabrication.

Principle disadvantages:

--for small outputs, higher specific investment costs through gas turbine and forced coal inlet.

--depending on process design, difficult, complicated hot gas filtering

--depending on process design, uncertain, long-term behavior of flue gas turbine

--low-flue gas speeds in the convection heated surfaces.

On the basis of these system studies, a concrete development strategy in being worked out by Steinmueller Co.

Initial objectives of the first phase are directed toward a fluidized-bed fired heating or power plant of small to medium size between 20 to 200 tons of steam per hour.

Steinmueller expects that besides the unpressurized, classical fluidized-bed configuration, for special applications, the pressurized fluidized-bed system and especially, the circulating (fast) system will become particularly important, if indeed the future does not already belong to them.

Steinmueller is offering provisionally a fluidized-bed system which differs somewhat significantly from previously designed systems, primarily by the boiler design and by the selected system process circuiting. The basic thinking is to get a better grasp on remaining latent problems and to avoid any unsatisfactory solutions.

Let us first discuss the boiler: To assure a good weak-point behavior, a separate chargeable and dischargeable nuclear/ring modulus design of pipe-bar-pipe construction with immersion vaporization heating surfaces is provided. Modulus separation continues down to the first compression space-integrated cyclone prefilter. An integrated bed material buffering is used to change fluidized-bed level, for start-up, shutdown and control purposes.

On the air/flue gas side, the boiler is incorporated into a gas turbine process for the lowest possible temperature range in connection with a turbocharger/blower cycle. This should achieve three things:

--a continuous operation over the entire pressure range (and thus, in connection with a fluidized-bed design adapted for it, a very large and quickly implemented control range)

--the use of a mass-produced, matured and relatively low-cost turbocharger aggregate, and

--the potential for using an already proven tissue or electrofilter for main filtering at temperatures below 300°C.

If higher steam powers are needed, the Steinmueller design provides for retention of unit size of this type of fluidized-bed boiler--appropriate to the present state of scale-up knowledge--within reasonable dimensions and to use a multiple arrangement of such units with joint supply and reprocessing periphery. This type of arrangement is possible both vertically and horizontally.

The use of fluidized-bed firing in large power plants is of interest to Kraftwerk Union (KWU). KWU is counting on the supercharged process with gas and steam turbines--as is Steinmueller.

As is known, the combination of a gas turbine process with a premium steam turbine process gives the greatest power plant efficiency. Thus it is also suitable for marking off the efficiency potential of plants with fluidized-bed firing. Figure 4 shows the circuit of such a design. The combustion air for the fluidized bed is moved by a compressor to the gas turbines at about 10 bar pressure. In the fluidized-bed firing, so much heat is transferred to the water/steam process that the flue gas temperature does not exceed a value of 850°C. The flue gas is filtered and relaxed in the gas turbine. The residual heat of the exhaust is used largely in the economizer and feedwater preheater.

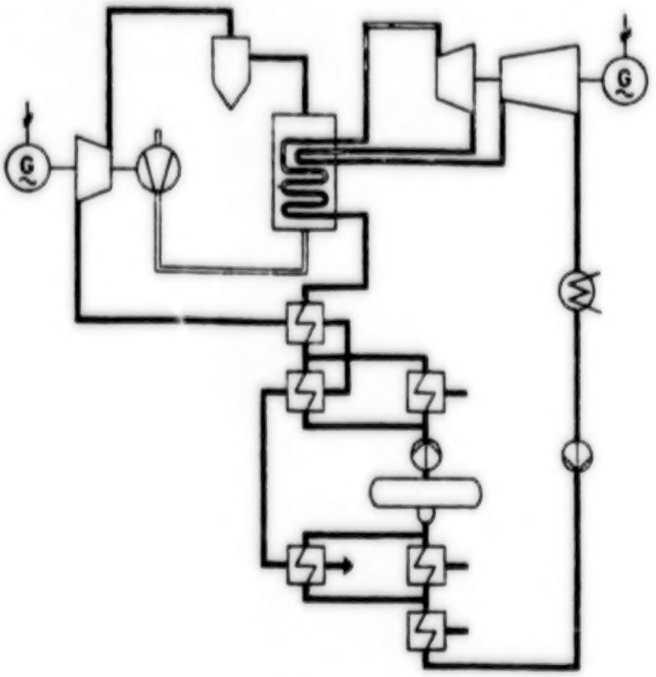

Figure 4: Flow Chart of a Combination Process Using FBF and Intermediate Reheater

The vaporizer, high pressure and reheaters are located in the FBF, whereas the economizer is heated with gas turbine exhausts. Studies have confirmed that even the reheater with its low thermal transfer coefficient can be housed on the steam side in the FBF, although the thermal flow density lies on the same order as in combustion chambers of coal dust fired boilers.

The unit power achievable with this circuit is produced 18 percent by the tas turbine and 82 percent by the steam turbine. The net efficiency amounts to 40 percent, the efficiency profile is shown in Figure 5. The profile is highly dependent on the partial load behavior of the gas turbine and thus drops quickly with decreasing load.

With this combination process, the maximum possible power plant efficiency (net) is achieved when using a fluidized-bed firing. An increase in bed temperature to values of 900°C increases the efficiency to about 41 percent, further significant improvements are not possible however, for reasons of process technology. This process is also distinguished by the unproblematic cooling of the bed with water/-steam carrying heating surfaces; the unit power is about 500 MW at a gas turbine output of 87 MW.

KWU still expects extensive development work to continue until these gas turbine/-steam turbine systems are used on a large scale. Emphasis is being placed on the gas side, since the steam turbine process is considered to be generally matured. On the gas side, there are three components--fluidized-bed firing, hot gas filter and gas turbine--for which there are current, extensive development programs underway.

The use of pressurized FBF stands or fall with a satisfactory filtering of flue gases in front of the gas turbine. The chances of success for separator developments are presently difficult to judge since, on the one hand, there is no dust separator currently on the market for high temperature, pressures and performance and, on the other hand, there is no long-term experience on fluidized-bed ash regarding dust accumulation in gas turbines. Under discussion are: electrofilters, rotary flow filters, ceramic filters, tissue filters and fixed bed-filters, pr circuiting a cyclone separator in front of one of these filters.

Besides a series of technical problems, KWU also sees material problems which have to be solved. For instance, the heating surface arrangement, fuel/limestone addition and ash removal must be coordinated so that burnoff and bubble formation lie within the desired limits. The behavior of large fluidized beds during heatup and load changes must also be examined; the same applies to partial load behavior. For pressurized plants, problems of solids introduction and withdrawal of 850°C ash must be included.

The gas turbine forms the third development emphasis because, when used behind a FBF, it acts both corrosively and erosively. Development work is concentrating on studies on corrosion and wear mechanisms, the development of wear-resistant blade materials and protective coatings, blade cooling to reduce corrosive attack and on design measures to affect the flow path of ash particles.

The filtering problem can be reduced provisionally by cooling the flue gas between the output from the FBF and the hot gas filter. The lower flue gas temperature would have a favorable effect on the corrosiveness of flue gases in the gas turbine.

The circuit shows that the gas turbine compressor moves the combustion air to the FBF of a steam boiler. The steam-flowing heating surfaces initially cool the gluidized bed and then, in a convection segment, the occurring flue gas, from 850°C to 430 degrees C. These heating surfaces are under a pressure of 9 to 10 bar and are thus relatively small because of the good thermal transfer.

The flue gases are scrubbed and relaxed in the gas turbine. The inlet temperature should be chosen so that the gas turbine just drives the compressor without giving off any power to the outside. A part of the gas turbine heat is used for preheating feed water.

The net efficiency of this design with supercharged boiler is just 38 percent and is on the same order as the conventional steam process without flue gas scrubbing. The efficiency advantage of the combined process is thus lost.

It is no longer difficult to get from the "coal gas turbine" to the pressurized fluidized bed with the GuD process. The big problem is that a high temperature gas cleaning must be performed to the extent that the gas turbine can be operated with acceptable service life.

The gas turbine manufacturer, BBC, has already moved into coal gas turbine development work and will develop, jointly with a boiler manufacturer, FBF for the combination process. BBC is following the same route as KWU--that the exhaust temperature of the fluidized bed should be cooled off by the boiler t a temperature below 400°C. At this temperature, BBC considers gas cleaning to be possible and estimates that dust contents below 35 mg/Nm^3 are attainable. Analogous to the KWU design, the exhaust will be fed o a turbocharger which charges the boiler only, without loss of useful power.

In order to reduce the development risk of such a combined process, it seemed expedient to examine the two partial processes in two independent pilot plants.

The Joint Committee of Gas and Water Works (AGW) Pilot Plant With Reduced Gas Temperature

The AGW, a joint project of Bergbauforschung GmbH, Essen, and Vereinigte Kesselwerke AG, Dusseldorf (VKW), has the objective of demonstrating that a gas turbine process with supercharged FBF in permanent operation is possible.

With support by the Federal Ministry for Research and Technology (BMFT), a pilot plant for a thermal power output of 25.3 MW is being erected on the grounds of STEAG power plant "Zeche Haniel." Figure 6 shows the schematic of the AGW pilot plant.

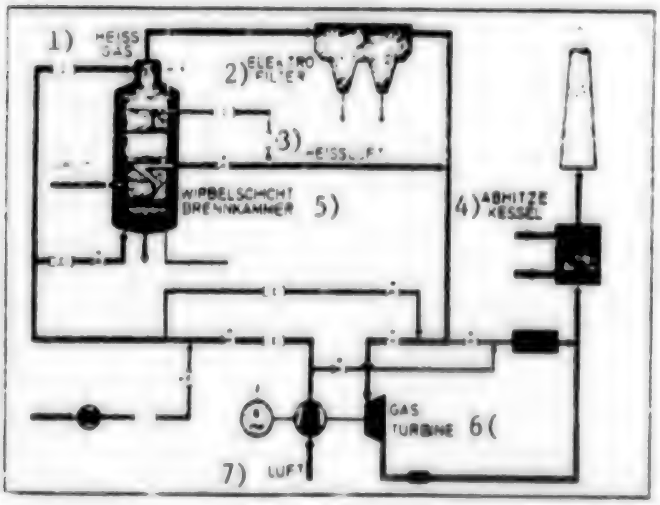

Figure 6: Outline of the AGW Pilot Plant

Key:

1. Hot gas
2. Electrofilter
3. Hot air
4. Waste heat boiler
5. Fluidized bed combustion chamber
6. Gas turbine
7. Air

The compressor compresses the intake air to 4.5 bar. The compressed air flows in two segments to the FBF chamber. The one segment is used as combustion air for the fluidized bed, the other segment is fed through the heat exchanger immersed in the FBF.

The combustion gas has a temperature of 860°C and mixes, after cleaning, with the hot air from the heat exchanger in the pressurized filter before entry to the gas turbine. The working gas has a temperature of 800°C at the design point and relaxes in the turbine to 475°C and releases a part of its residual heat to the outlet-connected waste heat exchanger.

In order that no significant erosion of the turbine blades occurs, an effective dust removal from the flue gas is a prerequisite for a safe, permanent operation. In accordance with this requirement, the filter is being developed in a separate research project.

The project to develop a hot, compressed gas electrofilter--also supported by BMFT funds--by Babcock-BSH, Krefeld, is an alternative to British and American solutions using cyclones or gravel filters. It is presently unknown whether this filter can achieve the flue gas cleaning at 860°C and 4.5 bar needed for a safe gas turbine operation.

The double mantle principle of the combustion chamber effects a separation of temperature and pressure stress. Here, the round vessel of 4.0 m diameter assumes the entire supercharging pressure. The inside vessel whose welded membrane walls form a gas-tight seal to the combustion chamber, only needs to withstand the pressure difference between inlet base and FBF.

Between the inlet base and heat exchanger pipes, there is a free space into which the pipes bringing in the coal-limestone mixture open and which is used to start up the firing.

Since the heat exchanger pipes are air cooled and since the different interior and exterior thermal transfer coefficients cause the pipe wall temperature to increase almost as high as the fluidized-bed temperature, the heat exchanger pipes are designed for the maximum bed temperature. A high alloy chrome-nickel steel will be used for these pipes.

Fuel introduction to the fluidized bed and ash removal occurs by means of sluice systems. The information gained from this pilot plant forms the background for construction outlines for a demonstration plant with an electric power output of 100 MW.

The IEA Grimethorpe Pilot Plant

Within the frame of an agreement of the International Energy Agency (IEA) under the guidance of the National Coal Board (NCB) in England (Grimethorpe/Yorkshire), a joint project of the United States, Great Britain and the FRG is underway. Experience gained in the operation of supercharged FBF by the BCURA is flowing into this project.

The max. 12 bar supercharging for a thermal power of 85 MW in this plant serves primarily as research and testing of the behavior of steam generator heating surfaces in the pressurized fluidized bed under changed operating conditions. Pressurization occurs by a steam driven compressor. Thus, in the interest of a safe operation, the problems of gas cleaning in connection with the operation of a gas turbine are avoided.

The water-steam carrying heating surfaces in the fluidized bed and in the separate heat exchangers used forced circulation. A special circuit assures that balancing of heat and substance flows can be implemented in the fluidized bed.

The fluidized-bed state--assuming proper flow-mechanical and reaction-kinetic design--affords a good synthesis of the three mechanisms of heat transport, material transport and chemical transformation. This also applies to the interesting energy gas/solid reaction of "coal burning" in a fluidized bed with 98 to 99 percent inert and 1 to 2 percent combustibles. Thus, a combustion system is available which is distinguished by five characteristics:

Characteristic 1

High thermal transfer coefficients within the fluidized bed

Consequence: Heating surfaces can be immersed in fluidized bed and in this manner, withdraw up to 60 percent of the fuel heat

This results in a clear reduction in boiler volume.

Characteristic 2

Low firing temperatures in the fluidized bed (ca. 750 to 950°C)

Consequence: General elimination of thermal NO_x; avoidance of danger of high-temperature corrosion and erosion; dry, rounded, soft and nonadhering ash grains

Characteristic 3

High use of the affinity between calcium and sulfur dioxide (SO_2) as a result of the temperature level and fluidized-bed turbulence.

$$CaCO_3 + \text{heat} \rightarrow CaO + CO_2$$

$$CaO + SO_2 + 1/2\ O_2 \rightarrow CaSO_4$$

Result: Effective, simple and low-cost desulfurization during combustion by limestone or dolomite admixture in a mole ratio of Ca/S = 0...3 (depending on accompanying mineral fractions in the coal or on the type of fluidized bed)

Characteristic 4

Carbon content needed in the fluidized bed only about 1 percent by weight.

Result: Opens up a broad band of fuels for burning (e.g. from high quality coal to flotation sludge)

Characteristic 5

Good mixing characteristic in the fluidized bed (especially in the fast bed)

Consequence: Relatively fast startup and shutdown phase.

Operating Experiences with Fluidized-Bed Firing

In ENERGIE 7/79, W. Voss of Standardkessel, Duisburg, reported on the design and structure of a boiler with integrated fluilized bed. At that time, there were still many open questions and engineers were unsure about many design and technical decisions. Since then, the plant has been operating for nearly 1 year with good results, according to the director of thermal technology at Standardkessel, Voss, speaking at the Coal Convention in Duesseldorf.

Startup and shutdown of the fluidized-bed systems were much discussed and almost feared. In the meantime, this has turned out to be an easily solved operating phase. The pilot plant with a thermal output of 6 MW is brought to pressure by a gas burner; this process takes 2 hours. At the same time, the temperature of the fluidized bed rises to about 600°C so that the coal can be fed in. Runup to full power then takes an additional 15 minutes.

At present, the plant is shut down in the evening. This has turned out to be unproblematic. During the 12-hour shut down, the poor thermal conducting bed mass only cools down to 450 to 500°C so that in the morning the Zued burner is only needed for 20 minutes to bring the temperature back to 600°C. Furthermore, the plant was often taken out of operation for brief periods. Startup was possible again each time without difficulties or delays.

A few changes in design of a new plant would be made, according to Voss. For example, the boiler was designed so that after an acclimation phase, an emptying cart was installed. From the previous operating experiences it can be said that in the next plants this spot will be occupied by convection heating surfaces.

At the Koenig Ludwig Pilot Plant the engineers decided on a natural cycle operation of the immersed heating pipes, with reference to the natural cycle of the boiler. However, no final statement about the stability of the flow can be given.

In order to be able to make safe statements about the water cycle in these immersed heating surfaces, extensive stability investigations were undertaken. In summary, Voss reported that the immersion heating surfaces have a very stable flow and thus certainly assure cooling.

In order to determine the corrosion and erosion behavior of these immersion heating surfaces, various current boiler steels were used. Since the entire ash quantity flows, as it were, through the boiler with the flue gas, the divisions of the individual bundle heating surfaces were adapted to this circumstance.

In the thermal design of the boiler, a certain fouling of the bundle heating surfaces was calculated in, and thus the external thermal transfer coefficients were evaluated accordingly. As previous operating experience shows, this was unnecessary. Deposits were found only on the inlet side of the bundle pipes. They are not baking, but very fine grain and of soft consistency. The dust could be removed by a gentle hand motion.

As a result of this favorable fouling behavior, the plant at full load has an exhaust temperature of about 160°C and not the designed 180°C. Steam outputs of about 13 t/h could be run with the boiler because of the good fouling behavior and the somewhat higher thermal transfer coefficients in the bed.

The soft consistency of the ash indicated a favorable behavior regarding erosion. But this will not be known until after longer operating times. Conclusions about whether the bundle divisions can be reduced must await these results.

To remove dust from the flue gas charged with a high dust content, a cyclone and tissue filter is outlet-connected to the boiler. The cyclone should prevent excessively hot particles from getting into the tissue filter. Inlet temperatures up to 250°C are permissible.

The dust occurring in the cyclone and tissue filter and that separated at the boiler, is moved via screw conveyor to a common conveyor belt. It then transports the dust into a container set up outside the building. At the boiler rear wall, a cooler conveyor screw is installed which removed any material from the fluidized bed. Thus, there is a central point for the entire plant for the collection of ash.

The filter effectiveness is so good that the legal regulations are easily maintained.

Besides positive experiences, there are a few points still needing development work. For instance, the still unsatisfactory burnoff of very fine coal particles once they have left the bed.

But if we consider the period needed for construction of a plant in comparison to the development work still needed, then even today the boiler with fluidized-bed firing is a genuine alternative for operators. The prevailing conditions and requirements will determine the potentials of fluidized-bed firing.

For instance, the spa at Lueneburg decided on a boiler with fluidized-bed firing not least for its environmental practicality. This plant is built built by a consortium of Thyssen Engineering-Standardkessel and the planning company Schmidt-Reuter. The hot steam boiler will be erected in the heating power plant and will take over heat supply to several administrative buildings and private consumers. At the same time, a turbine for electricity generation will be supplied.

The basic concept corresponds is that of the Koenig Ludwig plant.

Performance data of the plant:

Heat demand at full load	11.6 MW
Electric power output	1.2 MW
Steam power output	8 t/h

Hot steam temperature	320°C
Steam pressure	20 bar
Exhaust temperature	160°C

As fuel, hard coal of varying quality is provided.

Minimum heating value	13,810 - 27,340 kJ/kg
Ash content	6.2 - 30 percent
Sulfur content	0.8 - 2.2 percent

For smaller power output boilers, the introduction of fluidized-bed firing must be anticipated in the future. But in this range the boiler design will have to be altered in order to have cost-competitive plants.

Difficulty in Assessing Economy

Generally valid and accurate statements regarding the economy of boilers using FBF are still extremely difficult to make.

A comparison with conventional plants is unnecessary if a flue gas scrubber is needed. In this case, the boiler with FBF is always lower in cost since the expensive flue gas scrubbing system is not needed.

If no scrubber is needed, then the comparison cannot be between FBF and stoker firing, for instance, but must be more differentiated. Depending on the design, for instance whether the boiler is operating on a natural cycle, how coal feed occurs (mechanical or pneumatic) or whether coal crushing is necessary, there will necessarily be cost differences. For smaller- and medium-sized plants, these differences will be particularly noticeable.

List of Projects

Projects on Fluidized Bed Firing

Subject	Contractor	Grant funds
Setting up mature documents for a 100 MW coal power plant with pressurized FBF	Bergbauforschung GmbC/VKW	DM 26.2 million
Setting up & testing environmentally sound hard coal power plant with unpressurized FBF	Elektrizitaetswerk Wesertal GmbH	DM 18.2 million
Developing wear-resistant gas turbines behind high pressure FBF	KWU AG	DM 1.0 million
Experimental study of rotary separator behind high pressure FBF	KWU AG	DM 0.6 million

Gas purification for 100 MW_{el} behind pressurized FBF	Lurgi Umwelt & Chemotechnik GmbH	DM 1.5 million
Construction & operation of a pressurized FBF power plant	Project of IEA	DM 57.2 million
Construction & operation of an unpressurized FBF of 5 Gcal/h (useful heat/industrial firing)	Ruhrkohle AG	DM 4.7 million
Construction & operation of an unpressurized FBF of 30 Gcal/h (heating power plant)	Ruhrkohle AG	DM 10.4 million
Total planning of a boiler (230 t/h fresh steam) with circulating FBF	Stadtwerke, Duisburg	DM 3.7 million
Analysis Y optimization of startup of a coal power plant with FBF	Tech. Univ., Braunschweig	DM 0.2 million
Automatic firing system with FBF	University, Essen	DM 0.2 million
Remote heat plant with environmentally sound firing of ballast coal in a fluidized bed	Staatshochbauamt, Lueneburg	DM 5.9 million
Construction & operation of a circulating FBF (67 Gcal/h) in an aluminum oxide plant	United Aluminum Plant/Lippewerk	DM 17.8 million

9280
CSO: 3102

ENERGY

UNDERGROUND COAL GASIFICATION EXPERIMENTS PLANNED

West Berlin DER TAGESSPIEGEL in German 11 Oct 80 p 11

[Article by Marion Kern: "Coal Gasification at 1,000-Meter Depth"]

[Text] Since the oil crisis of 1973, a renaissance of "black gold," or coal, as an energy source has been in the making. Not just that coal production has been steadily increasing and there is no longer talk of shutting down mines, but also the oldest known processes for refining coal, which were rendered uneconomical and passed into history with the ascendancy of oil, are being recalled. These are liquefaction and gasification of coal. Through these transformations, a versatility of use which is today offered primarily by petroleum and to a lesser extent by natural gas will be realized for coal.

By the mid-1920's three different processes for the liquefaction of coal had already been developed which--as emphasized by Eng H. Waldmann of Erlangen at the Congress of the Society of German Electrical Engineers which concluded just this week in Berlin--practically exhausted the technical possibilities of the liquefaction of coal. To improve these processes and to make them economically attractive are still the objectives of research work on liquefaction of coal. Concerning the gasification of coal the situation is similar; the present, and in some cases commercially profitable, processes were already developed and used before 1940.

About DM 640 million has been disbursed by the Federal Ministry for Research since 1974 for improving the technology of coal gasification and liquefaction. Since 1977, 7 pilot installations for coal gasification have been put into operation in the FRG; 1 more is under construction. And about DM 13 billion will flow into 14 large industrial projects by 1993 with federal government participation. Presently, costs and risks of the proposed installations are being assessed in advanced projects; and engineering design support, location and environmental impact, time phasing and economics are being worked out. With positive results from these advanced projects, coal gasification can be expected immediately, by the end of this year, and coal liquefaction by 1981.

Economic Advantages Also

Economic advantages single out gasification of coal since this process is under better control, is more economical and requires less space. Additionally, liquid products can be produced from coal gas in subsequent stages. That gasification of coal, expecially in the presence of increasing coal prices, can also have significant economic advantages was underscored by Engineer Fichtner of Stuttgart at the Congress for Unification of Large Power Plant Operators which also met recently in Berlin. Under contract from German Shell AG his firm set up a comparison between a conventional coal-fired power plant and a power plant employing a coal gasification unit. In this the gas-fired power plant came out better in direct efficiency--43.2 percent compared to 38.7 percent for the coal-fired plant with exhaust gas washing. There was a slight advantage in investment cost; and, under the assumed doubling of coal prices, operating cost will also be lower for the power plant fired by coal gas due to its higher efficiency.

However, all of these processes depend on an increase in coal production which is reaching its limit because of greater depths and decreasing thickness of the coal seams. For making such coal reserves useable, the possibility of gasification of coal in situ began to receive attention in the FRG about 5 years ago. A focal point of the status seminar "Geotechnology and Deposits" which was arranged recently, also in Berlin, by the Federal Ministry for Research and Technology served to advance this research work. As emphasized by Prof G. Pusch of the Institute for Deep-Drilling Technology and Petroleum Production of the Technical University of Clausthal, both economic and environmental considerations speak for the underground gasification of deep-lying coal. In addition, the natural gas reserves could be doubled if all of the world's coal deposits deeper than 1400 meters were to be gasified with only 5-percent yield. This means that at the present level of consumption, instead of being exhausted at the year 2200, gas will be available for an additional 200 years.

To date, projects with a total cost of about DM 24 million have been supported by the Federal Ministry for Research which corresponds to 2 to 3 percent of the total cost of the FRG coal research program. Among these are studies of coal gasification behavior in the laboratory and the development of a computer program which will make possible the simulation of the process of underground gasification and the development of instrumentation methods.

With Steam and Oxygen

Likewise, the principle of underground gasification is by no means new. Between two holes drilled into the coal seam, a channel is burned through which the hot gasifying agent, a mixture of air and steam or oxygen and steam, flows under pressure. In the process the carbon of the coal is transformed into gaseous hydrocarbons. Both the USSR and the United States have practical experience with underground gasification; however this experience is not transferrable to the conditions in Germany since these tests were conducted in shallow lignite deposits. The first experience with gasification of hard coal at depths between 900 and 1,000 meters will be acquired from a German-Belgian field test at Toulin near the French border. Preparations for this test, whose cost is placed at DM 70 to 100 million, is underway at full speed. The required shafts--a total of 4.35 meters apart--have already been sunk. They pass through 3 coal seams, each with a thickness of more than 1 meter. Presently, preparations for the first tests involving injection of the gasifying agent are underway. The first test for burning a channel between 2 holes using hot air under a pressure of 50 to 300 bar will begin early next year. The underground gasification of coal is expected to begin in November, 1981.

This field test will determine whether the gasification of coal at great depths is technically possible and whether the principle is useable in Middle Europe. Unfortunately, the test conditions are not ideal. It was only learned upon drilling the holes that the coal seams beneath Toulin---where no mine shafts have been driven--have been seriously distorted by tectonic activity, and that the composition of the coal deposits is somewhat different from Ruhr coal. However, in view of the large sum already invested there is no inclination to seek out a more suitable test area.

Several Questions Still Unanswered

Early breakthroughs in underground gasification are not to be expected in any case due to the many questions still unanswered. For example, to achieve a high yield the permeability of the coal must be increased for penetration of the gasifying agent and for escape of the resulting coal gas. This could be accomplished by stream shock impulses or by artificial earthquakes. Practically nothing is known about the behavior of the cavities which result from underground gasification and which must remain as unobstructed as possible to permit further exploitation of the coal. Also the behavior of the coal-associated rock under heat and pressure still requires in-depth research. Finally, there is the problem of developing suitable pipe materials for handling the high-temperature gas flowing from the exit hole.

Not least and still unanswered is the question of how to optimally control the underground temperature and therewith the gasifying process. Nonetheless, Pusch is optimistic. In 20 years, he emphasized, underground gasification will also be economical; in addition, considering both production and use, it will be 2 to 3 times more advantages than above-ground gasification.

9160
CSO: 3102

BUDGET REDUCTIONS AFFECT SWEDISH ENERGY RESEARCH

Stockholm NY TEKNIK in Swedish 21 Aug 80 p 3

[Article by Ulf Bergmark]

[Text] Sweden will withdraw from European cooperation in fusion research. Development will be postponed.

Many energy research projects will never be started. Those will be the results if the government's austerity plans affect Swedish energy research.

That is what is being claimed by the DFE (Energy Research Commission), which is now presenting a proposed energy research program for the period up to 1984. The DFE has overall responsibility for energy research.

The DFE claims that energy research will have to receive 1.4 billion kronor over the next 3 years. The proposal, known as EFUD 81, covers the fiscal years from 1981-1982 to 1983-1984. It will form the basis of the government's energy bill in the spring of 1981.

The reason for the sharply increased need for money is that energy research in many areas is now leaving the drawing boards and the laboratories to be tested on a large scale.

At the government's request, EFUD 81 also includes an alternative at the present economic level. It totals 1 billion kronor for the same 3-year period and calls for a more or less drastic reduction in energy research in all areas.

Fusion research will be the area hardest hit if the appropriation remains unchanged. Sweden would then withdraw completely from European cooperation on the Jet Project at Oxford. The EC agreement is so worded that each partner country must pay its full contribution--in Sweden's case, 60 million kronor—or withdraw completely.

The phasing-out costs associated with breaking the EC agreement total 12 million kronor. The alternative to canceling cooperation in fusion research is to make drastic reductions in all other energy research. But that is considered unreasonable.

But energy research will be affected in a number of areas in any case if the appropriation remains unchanged.

In the industrial program headed by the STU (National Board for Technical Development), the first to go will be the long-term investments. Among other areas, this will affect support for new paper technology. Projects concerned with continuous casting, surface treatment, and so on will not get any money, either.

Solar Energy Research

Solar energy research under the BFU (Building Research Council) will be cut back. Among other things, this will affect the development of solar collectors, new types of heat pumps, and chemical energy storage techniques.

The SOL-85 program will be postponed for about 2 years. This means that it will be 1987 before solar energy researchers will be able to talk about which solar technology it would be most appropriate for Sweden to invest in.

The methanol program might also be postponed. The automobile engine designed to operate on pure alcohol, which Volvo is expected to have developed by 1987, will never see the light of day if the overall budget is not changed.

The NE (Committee for Energy Production Research), which under this proposal would get half of the research money available, would also have to cut back on a number of projects:

Research into energy from forests will be proportionally hardest hit. The budgeted 30 million kronor for forest terminals will be eliminated entirely. And the same goes for 10 million kronor allocated to research into new inventory technology.

Peat: the 20 million kronor for major research with new peat cutting methods will be completely eliminated. Environmental research will also be cut back.

The cultivation of energy plantations will suffer a 10-million-kronor cutback. Major cultivation research with energy crops will be eliminated. Support for the development of new reed harvesting machines will also be scrapped.

Wind Power

The wind power program, on the other hand, will be reduced only slightly, since the government is committed to the two wind power plants ordered from the Karlskrona Works and the KMW (Karlstad Engineering Company).

Basic research is also being choked off. Among other things, the environmental research supported by the National Science Research Council will be sharply reduced.

Projects close to a commercial breakthrough--for example, forest energy and peat--have been cut more sharply. The reason is that the success or failure of those projects is not regarded as dependent on state support.

The cutbacks in those projects in which research support is the driving force--for example, the cultivation of energy plantations and, to some extent, solar energy research--have been more moderate.

The DFE's main proposal--for 1.4 billion kronor--includes no new ventures. It is being proposed that the authorities in charge of Swedish energy research continue working within the present programs.

Organization Remains

The commission states in EFUD 81 that there is no reason to make changes in the energy research organization itself, even if energy research is being reduced.

That can be regarded as an answer to Sven Moberg's report on the distribution of work among energy authorities that was published in May. In that report (No I 1980:16), it was claimed that the organization is unnecessarily complicated and that both the DFE and the NE could be eliminated (see NY TEKNIK No 27:1980).

What is new is that the program for safety research in connection with light water reactors is being transferred from the NE to the Swedish Atomic Energy Board. With that step, all research concerning fission reactors will be removed from the energy research program.

Adjustment

The above is only an adjustment to reality, since the NE has functioned as an intermediary that has simply passed the money along to the Atomic Energy Board, the National Institute of Radiation Protection, and Studsvik Energy Technology.

Per Stranglert, who was responsible for the compilation of EFUD 81, says, "Those authorities are responsible for safety in the existing reactors. The NE's participation was intended partly for research concerning future types of reactors. But now, of course, we are not going to have any nuclear power after the year 2010, so the NE's involvement is unnecessary."

Another new feature is that all research and development in the field of solar heat, heat pumps, heat storage, and heat distribution will, according to the proposal, be transferred to the BFR.

The DFE does not want to anticipate its response to that report, which is to be submitted in September, but it admits that the present energy research organization has its shortcomings.

One example is the fact that the boundary between the NE and the STU on the one hand and the National Industrial Board on the other is partially problematical. The Industrial Board supports energy research with subsidies for prototypes and experimental projects.

Moreover, the next budget year will probably see the appearance of a new fund for the support of new energy technology, as proposed by the Commission on the Replacement of Petroleum. To some extent, it may be included in the DFE's area of responsibility, and its influence on the energy area is expected to be very sizable.

It is clear that the government will do some weeding in this tangle of energy authorities. But at the DFE, it is believed that a new government energy organization will not be created until the EFUD 81 program is completed 4 years from now.

11798
CSO: 3102

WORLD'S LARGEST SOLAR-HEATED RESIDENTIAL AREA

Stockholm NY TEKNIK in Swedish 28 Aug 80 p 15

[Report by Ulf Bergmark]

> [Text] Construction will begin in Uppsala next year on the world's largest solar-heated residential area. Uppsala Kraftvärme AB [Uppsala Power and Heating, Inc.] made that decision recently in spite of financing problems. Only a part of the solar collector surface needed will be installed. The rest is being put off to the future.

Five hundred apartments and a 100,000 m^3 underground reservoir for hot water will be built in Sorvreta, north of Uppsala. But 20,000 m^2 of solar collector surface that would provide the residential area with year-round heat is being reduced to 3,000 m^2.

The reason is that early in June BFR, the Building Research Council, cut the requested grant down from 25 million kronor to 17 million kronor.

The underground reservoir will therefore be partly heated by an electric boiler that will simulate 17,000 m^2 of solar collector surface.

Uppsala Kraftvärme AB will look for other means of financing full-seale construction of the solar collectors, which would make any additional heat unnecessary. Partly to throw light on the architectural and social consequences that such a big solar collector may have.

"We are in no hurry about constructing the solar collectors, since the price trend in solar collectors is very favorable. The solar collectors we can get a few years from now will be cheaper and probably better, too," says Hans Nordström of Uppsala Kraftvärme AB, who is taking part in the project.

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SWEDEN LOOKS TO PEAT AS SUBSTITUTE FUEL

Stockholm DAGENS NYHETER in Swedish 2 Oct 80 p 9

[Article by Ake Ekdahl]

[Text] The peat operators are standing in line at the National Industrial Board. The Ministry of Industry is expecting a rush when the subsidies are ready for those switching from oil-fired boilers to peat burners. The forestry company of ASSI [expansion unknown] is already importing Finnish peat. In 3 years the central hot water plant in Gallivare will go into operation. At least three big plants are to follow. There is going to be a "peat rush." Today no one knows how long the raw material will last.

Sweden stopped using peat as a fuel 13 years ago. In the 1940's, 7.5 million tons of fuel peat were extracted in a 10-year period. The research plans for the 1980's call for extracting that much in 1 year, in which case the peat would last for 100 years. It would replace 5 percent of today's oil consumption.

Sweden is in fifth place among the world's peat nations. The Soviet Union is way ahead of all others. The Soviet Union also consumes the most: 95 percent of all production. Ireland and Finland also use peat in considerable quantities for heat and the production of electricity. But advanced plans for peat facilities exist in a number of countries: the United States, Canada, Greece, Poland, the FRG, the GDR, and Sweden.

One out of every 10 square meters in Sweden consists of fuel peat. Most of it is in Norrland. The supply of peat is almost unlimited, but only a small portion can be utilized, owing to environmental considerations and the difficulties involved in extracting it.

Inventory

This spring the county administrations will complete a nationwide inventory of the supply of forest wastes, and some counties will also include peat.

Even the SGU (Geological Survey of Sweden) is calculating the supply of peat available for energy production at the request of the Committee for Energy

Research. When it is completed, we will know more about the number and quality of Swedish peat bogs.

Peat merchants and operators are standing in line at the licensing authority. So far nine have obtained preliminary licenses from the National Industrial Board to explore the workability of deposits, and two have operating licenses. In just the past year, five others have applied for operating licenses, while 19 have applied for exploration licenses. Those standing in line include forest companies, communes, energy firms, farmers, and an occasional private landowner.

Peat Imports

Last summer the ASSI forest company received 6 million kronor from the government to start up its own peat digging operation. The firm currently imports peat from Finland by truck. A newly established company called NYDO (Nynas Petroleum and Forest Service) has received money for a wood chip terminal in Ostersund with an ulterior motive: it will store peat there for the future combination heat and power plant. A consortium in Vasterbotten has also obtained government help for a similar peat depot.

Firms that invest in experimental facilities that use peat or other domestic solid fuels in place of oil now have half of their investment paid by the National Industrial Board. Even exchanging one's oil-fired boiler for a wood-fired boiler entitles one to a 35-percent subsidy from the state.

New money from Minister of Industry Asling will soon be available for anyone who can come up with interesting research projects or ideas creating jobs where there is high unemployment. And Minister of Energy Petri is providing investment fund money for those who replace oil with other fuels.

So far peat has not aroused any political opposition. Parliament is therefore expected to reach its formal decision this spring concerning development of the first of at least four big peat plants in Norrland.

Umea and Ostersund will get combined power and heating plants (that provide both heat and electricity), while Boden and Gallivare are getting central hot water plants. The State Power Board and the local energy firms are designing these together.

Peat-Fired Heating Plant in 1985

First in the plan is Gallivare, whose central hot water plant will be ready in the fall of 1983. Currently being evaluated are the prospects of building this first big peat facility to produce 20 megawatts, which would be enough to heat half of Gallivare. Perhaps a second facility will be added.

Two years after that it will be time for a similar central heating plant in Boden.

In the fall of 1985 the first combined power and heating plant using peat will be ready for use in Umea. It will supply 33 MW of electricity and 70 MW of heat.

Plans are already being made to purchase peat from the Swedish Forest Service, the LKAB Mining Company, and other possible sources. The Umea plant will require 250,000 tons of fuel peat per year, representing about 7,500 fully loaded large trailer trucks.

The Umea plant is also expected to be included in this spring's energy bill.

The similar plant in Ostersund will come 2 years later.

We are learning our peat technology chiefly from Finland, which for several years has burned 700,000 tons annually in several medium-sized heating plants and one combined power and heating plant. The methods of processing peat are also being studied at the moment by the National Board of Physical Planning and Building.

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PEAT ENERGY PLANT TO BE BUILT AT JOENSUU, FINLAND

Helsinki HELSINGIN SANOMAT in Finnish 23 Sep 80 p 24

[Article: "Location of Imatra Power's Large Peat Power Plant Kept Secret"]

[Text] A location is being sought in strict secrecy for Imatra Power's first large peat operated power plant in Joensuu. IVO [Imatra Power] and the city of Joensuu reached an agreement a year ago on the construction of a 200-million markka peat power plant, but it is now feared that the location of the plant will be opposed by local residents and environmental protectionists.

On Monday representatives of Imatra Power argued the advantages of their plans and location alternatives before the city council of Joensuu. City Director Auvo Heikkila only consented to state that a decision concerning the location of the plant will be made by the city council toward the end of fall.

"I have such a poor memory as far as names are concerned that I do not even remember the names of the individuals from the power company. A location is being sought, but I cannot say where," stated Heikkila.

It is feared that Imatra Power's test plant will contribute a considerable amount of noise and pollution to the environment. From the very beginning the whole venture has been treated with secrecy in the city's administration.

Imatra Power's peat power plant will be the second largest electric- and thermal power plant in eastern Finland to use domestic energy. The expansion on the peat power plant in Kuopio resulted in its peak production a couple weeks ago. The Joensuu Plant will produce 60 MW of thermal heat and 120 MW of electricity after 1983.

Timonen Promoted Subsidy Struggle

Governor Esa Timonen of Pohjois-Karjala [Northern Karelia] urged the people of his province into a struggle for retaining small sawmills and the transporting of lumber at a luncheon for members of the Diet in Joensuu.

According to Timonen the industrial development of the Province of Northern Karelia is poor compared to the other underdeveloped provinces. In his opinion the proposal of the Ministry of Trade and Industry to eliminate the transporting of lumber is a severe blow to Finland's poorest areas.

"We would be fools if we allow this to happen. When I was minister of transportation, I promoted subsidies for transportation, subsidies which are now being cut back by 70-80 percent in Northern Karelia," thundered Timonen.

Northern Karelia's unemployment rate has been 8 percent in spite of "good times" or just as high as the unemployment rate in southern Finland during a recession. Also the establishment of new enterprises in the province has been slow in spite of the improving economy.

10576
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BUDGET CUTS CAUSE FINANCIAL WOES IN FRG RESEARCH MINISTRY

Frankfurt/Main BLICK DURCH DIE WIRTSCHAFT in German 27 Sep 80 p 1

[Article by T.N.: "Research Ministry in Financial Trouble"]

[Text] Frankfurt, 26 Sep--In 1979, the Ministry for Research presented a budget proposal for 1980 which estimated the research expenditures for this ministry at DM 6.17 billion. Compared to 1979, it would have been an increase of 11.1 percent. In the meantime several measures reduced this 1980 budget of the Ministry of Research to such an extent that the funds available for 1980 are even less than those for 1979. These various measures are as follows:

Bundestag resolutions of December 1979 concerning the budget proposal led to a reduction of the total budget to DM 6 billion. In May 1980, the amended budget of the Federal Government led to a reduction of the budget to DM 5.85 billion. Freezes by the FRG minister of finance led to an additional reduction of DM 83.7 million, bringing the budget down to DM 5.77 billion. The freeze of DM 231 million by FRG Minister of Finance Matthoefer in the summer of 1980, in accordance with the Federal Budget Ordinance (Article 41), led to a freeze of DM 231 million and thus reduced the research budget to DM 5.5 billion.

Consequently, the Ministry for Research has to manage with a 1980 budget that is smaller than the one in 1979, although original expectations were very optimistic and led to a considerable expansion in the number of promises made by research administrators. The severe reduction in research expenditures has several practical results. Since the middle of 1980, hardly any projects have been seriously considered.

At the present time, extensive propaganda for state research funds, however, does not lead to success for applicants, but it causes an enormous amount of red tape because the funds for the promotion of research were reduced. How does it affect the person who applies for funds for the promotion of research in the economy?

It means, in particular, that at the present time one has to weigh carefully whether the expenses for the application procedure are worthwhile at all. The Ministry for Research has hardly any disposable financial means. Nevertheless, the administrative apparatus for research is maintained. It means that the applicant's expenses are considerably greater but the chances for success are smaller, because there is no money at all.

In 1980, as a result of Bundestag resolutions, the most massive research cuts were made in the following areas:

Data processing, DM 17 million,
Information technologies, DM 14.5 million,
Reactor security, DM 24 million,
Reactor development, DM 50 million,
Nonnuclear energy, DM 53 million,
Uranium supply and fuel element development, DM 16 million,
Communications satellites, DM 11.8 million.

In spite of recent internal cuts within the Ministry for Research, the request by the minister of finance for additional cuts of DM 231 million has not yet been accomplished; by September 1980 the amount was DM 185.5. By the end of the year, the ministery still has to cut an additional DM 45.5 million in individual areas.

In conclusion, during the last 20 years the Ministry for Research never experienced such difficulties in financing its projects as has been the case in 1980.

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TRANSPORTATION

WESTERN AIRCRAFT MAKERS WOO JAPANESE PARTNERS

Duesseldorf WIRTSCHAFTSWOCHE in German 10 Oct 80 pp 86-87

[Article: "A World Jet From Japan"]

> [Text] Japan's aircraft industry is being courted intensely: all the major passenger aircraft manufacturers are journeying to the Far East to sound out the chances for cooperation on new airliners.

During the international Air Show in Farnborough, England, it was already clear to the daily exhibition information news service DAILY NEWS on 1 September: "The sun is rising over the F 29." The sun of Nippon: the Dutch aircraft manufacturer Fokker BV, a David among the industry Goliaths, was in the lead for the sought after cooperation with the Japanese.

Under the code initials Y-X-X Japan's aircraft industry has been pursuing plans for a considerable period for a narrow-bodied aircraft for 130 to 150 passengers. An undertaking of this magnitude cannot be managed alone by a newcomer to the international aviation scene. So European and American industry colleagues detected a welcome opportunity of using the technological power of the Japanese and sharing development costs. Similar studies had been started in the established aircraft shops, although no one had yet been able to decide to become totally involved in such a program.

Market opportunities seem rosy: after the big-body jet boom thousands of short- and medium-range machines, like the Boeing 727 and 737 and the McDonnell-Douglas DC-9, which have since reached the limits of their developmental potential, will have to be replaced in the 1980s and 1990s.

Boeing chief Thornton A. Wilson was among the high-ranking travelers to Japan who wanted "to jump onto the bus." In the spring he had announced for all to hear: "We are prepared to investigate the joint development of a jet in the 130-passenger category."

Until then the Americans had shown great reserve about plans in the Far East. But Wilson's visit to the land of the rising sun startled his competitors. Subsequently, Western aircraft builders have been treading on each other's heels in Tokyo. McDonnell-Douglas offered its cooperation on the DC-9's successor, the ATMR, and Lockheed held out the bait of granting a license for the turboprop transport plane L-100.

What principally irritated the Americans, who have worried about their market supremacy since the success of the Airbus, were the Japanese contacts, little regarded at first, with the European aircraft industry. True, the British had been unsuccessful with their offer to sell an improved version of their BAC 1-11 in the Far East. But at the beginning of the year a 26-member group of representatives from the Japanese Association of Aerospace Industries traveled to Great Britain, as well as to France, Spain, the Netherlands and the FRG. During their 2-week trip to Europe they were recruiting for their Y-X-X program and gained an overview of project studies and the manufacturing capacity of the Europeans.

At Airbus Industry they saw the SA-1/SA-2 studies: until now only half-heartedly pursued plans for a family of aircraft which, with 130 and 150 seats, is far below the capacity of today's big-body airbuses.

The Japanese were very attracted by the plans of the Dutch aircraft manufacturer Fokker, which has been launching new activities since the beginning of the year, following the split from its German partner of many years, the United Flight Works (VFW). After the exemplary success of the F 27 (with turboprop engines) and the F 28 (short-range jet), which was more difficult to sell, Fokker has been working with astonishing energy on the F 29 project--a highly ambitious undertaking for a fairly small manufacturer in the international airliner business. Fokker needs a partner, if the program is to be started in mid-1981--as planned--and if it wants to deliver the first production machines by 1984.

At the end of April a Dutch Government delegation arrived in Tokyo on a reciprocal visit, led by Prime Minister Andries van Agt, and presented a detailed offer of cooperation. Finally, equalizing the balance of trade between the two countries played an extremely important role.

The Boeing people immediately followed: in mid-May both vice-presidents, W. M. Maulden and W. W. Buckley, were in Japan to continue cultivating the ground explored by their chairman. The Americans can register the already existing smooth cooperation in the 767 program as an important plus. Japan's Mitsubishi Corp is building body sections for this Airbus competitor.

But the match remained open. In August the Japanese conducted renewed discussions with both Fokker and Boeing. The game was given extra spice because Fokker was also trying to flirt with Boeing: the Dutch would long ago have liked to adopt certain component groups from the Boeing 737 to save development costs.

The probability is high that a three-way flirtation between Japan, the United States and the Netherlands will develop. This would certainly be something new in international passenger aircraft construction.

The Japanese have been involved in the aircraft business for some time. In December 1979 the British engine manufacturer Rolls-Royce Ltd and the three Japanese firms Ishikawajima-Harima Heavy Industries (IHI) Co Ltd, Kawasaki Heavy Industries Ltd and Mitsubishi Heavy Industries Ltd concluded a contract for the joint development of a new jet engine with a thrust of between 9 and 10 tons, just the right class for the future generation of airliners.

Great Britain and Japan are to share the development costs of more than $600 million as well as production. A joint company is being established in English to complete this cooperation, a 50-percent share of which is being assumed by both Rolls-Royce and the Japanese industry.

The Japanese are not without experience in modern jet engine technology. For 5 years they have been building the most up-to-date military high-performance turbines under license from the best-known manufacturers, Pratt & Whitney Aircraft, General Electric Co, Rolls-Royce and Snecma. Out of their development offices came prototypes like the 5-ton jet engine FJR-710, whose technology is to be combined with the Rolls-Royce project RB-432 in the joint RJ-500 engine.

The competition in the engine sector left the starting line a long time ago. The American-French 10-ton engine CFM-56, which was developed by General Electric and Snecma, is already entering volume production, and Pratt & Whitney has already run tests with its partners, the Motor and Turbine Union Co Ltd (MTU) in Munich and Fiat in Turin, on the new JT-10D engine. Japan will naturally favor the RJ-500 for the new airliner. If the Dutch-Japanese-American joint jet wants to take advantage of all its market opportunities, the choice among the three engine types will have to be left open to the airline companies. Already Rolls-Royce is facing stiff competition, principally from Pratt & Whitney and General Electric, who are preferred by the airlines. The ground is being prepared for cooperation which will link almost all the Western nations active in aircraft construction. Japan's three-way affair is leading up to the "world-jet" of the next decades.

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TRANSPORTATION

DORNIER INTRODUCES NEW SERIES, NEW TECHNOLOGY AIRFOIL

Rome AVIAZIONE in Italian Sep 80 pp 543-545

[Article by Vito Tullio: "From Germany, New Projects with New Wing--the Programs of the West German Firm Which, With the Support of the Bonn Government, Announces a New Family of 'Utility' and "Commuter' Aircraft as Successors to the Skyservant"]

[Text] Hanover--If there had been any suspicion that Dornier's program for the "Tragfluegel Neuer Technologie" [New-Technology Transport Plane] (TNT) was only a technological exercise, the most recent indications given by the West German builder at the Hanover show regarding application of the so-called "new-technology wing" to production aircraft dispelled all uncertainty. Indeed, announcement was made of a new series of aircraft, known as "228," which Dornier intends to introduce onto the utility and commuter market soon: 15 passengers for the Do-228-100, 19 for the slightly longer Do-228- 200; first flights in Spring 1981 and at the Paris aerospace show in June.

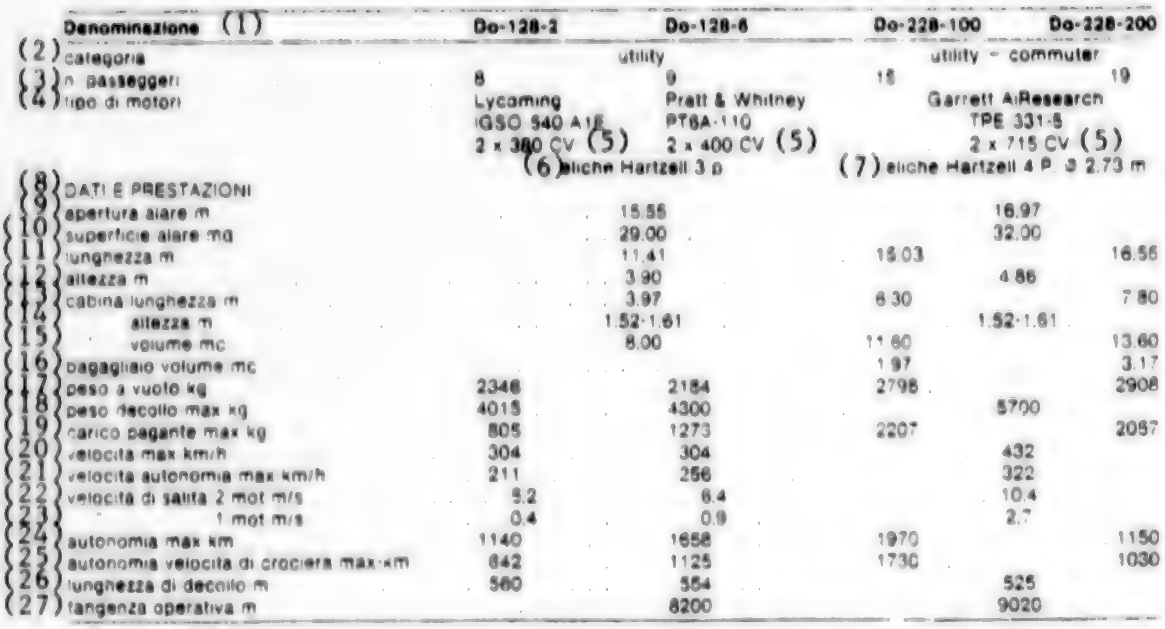
This, in sum, is the most interesting program of the Friedrichshafen (Munich) group, although there is no lack, in the short term, of other new things in that sector in which, since the middle of the 1950's, Dornier has taken its place in the world market with the sale of a total of about 1,000 Do-27's, Do-28A/B's, and Do-28D-2 Skyservants, from which the most recently announced series, the Do-128, derives. It is best, though, to take Dornier's projects in order. The Do-128 is the latest model of the Skyservant, with 10 seats in utility arrangement. Two different versions of this aircraft are offered, as regards the propulsion unit: the Do-128-2, which continues with piston engines (Lycoming IGSO-540A1E, 380 HP, with takeoff weight of 4,015 kg); and the Do-128-6, which has turboprop propulsion using two Pratt & Whitney PT6A-110's of 400 HP--and this in essence is the turbine production version of the Skyservant, which has already flown for the first time, last March, and was presented at the Hanover show.

The Do-128-6, the first deliveries of which are expected in 1981, has a takeoff weight of 4,300 kg and a payload about 450 kg bigger (1,273 kg as against the 805 kg of the preceding model). Apart from the enhanced performance characteristics, the main reason why Dornier has "turbinized" the

Skyservant is explicitly the increasing shortage of aviation fuel for piston engines, which, in addition to being more and more difficult to find at airports, is also more expensive. "At the present levels," the firm adds, "the price of aviation gasoline (Avgas) is roughly 50 percent higher than the fuel for turbine engines, and the difficulties of supply, especially in the Afro-Asian countries, will make its price rise even more." Aviation gasoline is produced in only nine countries today, representing a very small proportion of petroleum business and the profit from it; and this, after the Iranian crisis, appears to have led the producers to reduce its proportion even further in favor of other petroleum derivatives. In view of these problems, in addition to the advantages of the turboprop over the piston engine (longer life, greater reliability, and longer TBO [Time Between Overhaul] periods), a considerable increase in the demand for turbine engines in the general-aviation market is indeed foreseeable.

The Do-128-6, whose progenitor was the Do-28D-5X (Turbo-Skyservant) experimental aircraft, is distinguished by structural reinforcement of the engine mounting, a new fuel tank and other equipment, offering a 25-percent increase in range, for the same payload, and a 20-percent increase in speed over the original Skyservant. The PT6A-110 engine, similar to the A-21 and A-27 series, limits the power required to 400 HP; and the propeller's RPM drops from 2,200 to 1,900, decreasing noise and fuel consumption. Vis-a-vis the piston-engine Do-128-2, the turbine-powered aircraft presents similar direct per-hour operating costs and lower costs per ton-km; it obviously improves the performance characteristics at higher altitudes and temperatures and the rate of climb on one engine. Maximum speed at altitude of 3,300 m is 340 km/hour, and the range, with 800-kg payload, is 1,460 km without reserves. The Skyservant, again, is the subject of a project to change over to piston engine with Lycoming TIGO-540 turbocompressor for the FRG Air Force (it will be recalled that 120 Skyservants are in service in Bonn's Air Force and Navy); the prototype, Do-28D-2T, flew last March from the Oberpfaffenhofen firm's airport. It is stressed that this aircraft, in the development of which MTU [expansion unknown] and Lycoming are taking part, has, among other things, a considerable reduction of noise (10 dBA).

But the FRG Ministry of Research and Technology is to be credited with Dornier's beginning, in June 1979, the first flights of the Skyservant-TNT, an experimental aircraft with the "new-technology wing," which more generally represents a program of development in different areas for utility and commuter aviation. The TNT is a new type of wing that puts into practice the progress in subsonic aerodynamics of recent years and follows the trend of "supercritical" applications and development of new profiles for general aviation (GAW) in the United States. This wing design, modified in plan as well as in profile, offers considerably improved aerodynamic characteristics (for example, in maximum efficiency and lift/drag ratio), which Dornier declares to be fully confirmed in the flight tests vis-a-vis the theoretical studies. In particular, the form in plan is of the rectangle-trapezoid type, ending in two triangular tips; structurally, therefore, the wing design is composed of a continuous rectangular box, two slightly dihedronal trapezoid sections, and two triangular tips; the flaps are Fowler single-



Denominazione (1)	Do-128-2	Do-128-6	Do-228-100	Do-228-200
(2) categoria	utility		utility - commuter	
(3) n. passeggeri	8	9	15	19
(4) tipo di motori	Lycoming IGSO 540 A1E 2 x 380 CV (5)	Pratt & Whitney PT6A-110 2 x 400 CV (5)	Garrett AiResearch TPE 331-5 2 x 715 CV (5)	
	(6) eliche Hartzell 3 p		(7) eliche Hartzell 4 P. ⌀ 2.73 m	
(8) DATI E PRESTAZIONI				
(9) apertura alare m	15.55		16.97	
(10) superficie alare mq	29.00		32.00	
(11) lunghezza m	11.41		15.03	16.56
(12) altezza m	3.90		4.86	
(13) cabina lunghezza m	3.97		6.30	7.80
(14) altezza m	1.52-1.61		1.52-1.61	
(15) volume mc	8.00		11.60	13.60
(16) bagagliaio volume mc			1.97	3.17
(17) peso a vuoto kg	2346	2184	2798	2908
(18) peso decollo max kg	4015	4300	5700	
(19) carico pagante max kg	805	1273	2207	2057
(20) velocità max km/h	304	304	432	
(21) velocità autonomia max km/h	211	256	322	
(22) velocità di salita 2 mot m/s	5.2	6.4	10.4	
(23) 1 mot m/s	0.4	0.9	2.7	
(24) autonomia max km	1140	1658	1970	1150
(25) autonomia velocità di crociera max km	842	1125	1730	1030
(26) lunghezza di decollo m	560	554	525	
(27) tangenza operativa m		8200	9020	

Key:

1. List of characteristics
2. Category
3. No of passengers
4. type of engines
5 HP
6. Hartzell 3-blade propellers
7. Hartzell 4-blade propellers
8. Data and Performance Characteristics
9. wing span in meters
10. wing surface, square meters
11. length, meters
12. height, meters
13. cabin length, meters
14. cabin height, meters
15. cabin volume, cubic meters
16. baggage volume, cubic meters
17. weight empty, kg
18. maximum takeoff weight, kg
19. maximum payload, kg
20. maximum speed, km/hour
21. maximum-range speed, km/hour
22. 2-engine climbing speed, m/sec
23. 1-engine climbing speed, m/sec
24. maximum range, km
25. range at maximum cruising speed, km
26. takeoff distance, meters
27. operational ceiling

slots. The structural design of the TNT is no less interesting than the aerodynamic design, with the adoption of extensive integral construction using digital-control machines with the same production technology as for the wing of the Alpha Jet; according to the firm, this achieved an optimized design without equal in aircraft of this class today. For example, the upper and lower panels of the central box are milled on CN [numerically controlled] machines from aluminum sheet 50 mm thick from which 90 percent of the material is removed, down to local thicknesses of 1.3 mm. Along with the weight optimization and the small number of structural components, a lower number of man-hours are needed for production, and one has external aerodynamic surfaces without riveting. The trailing edge of the wingspread ends in fiberglass elements and sandwiches that are completely removable over the whole span for access to the flap and aileron control parts.

In addition to the new type of wing, the experimental Skyservant replaces the piston engines with Garrett AiResearch TPE 331-5 715-HP turbines, the use of which is also planned for the Do-228 aircraft series; the prop RPM is 1,590 with blade-tip speed of Mach 0.67 and particularly low noise levels (75 dBA was recorded during overflights at an altitude of 330 m). The landing gear has been replaced with a three-wheeler, and one notes curiously that the aircraft has adopted that of the Alpha Jet. After the presentation at Hanover, the Skyservant-TNT is supposed to have continued with its test-flight program at the DFVLR [German Research and Development Institute for Air and Space Travel] center of Braunschweig, with the project used as a test bench for numerous areas of investigation (aerodynamics, structues, propulsion and avionics) with a view to new commercial programs. In addition to the new-technology wing, other research projects have indeed been added to the same Dornier, among which are guidance and navigation systems, gust-alleviation, and structures made of composite materials (carbon fibers). Following this experimental aircraft, the Do-228 program has finally taken shape, presented, as was said, in two models, the -100 and the -200, with respective capacities of 15 and 19 passengers in the passenger version. The central section of the fuselage is still that of the Skyservant, with the D-228-200 distinguished, for example, by a cabin length of 7.80 m; the maximum takeoff weight--5,700 kg--is the same for the -100 and the -200, and maximum cruising speed is 430 km/hour. The engines planned remain the TPE 331-5's (715 HP), or as an alternative, the PT6A-135's (750 HP); later possibilities are the TPE 331-10's (685 HP) and PT6A-41's (850 HP). The builder's policy, in any case, does not appear to take the Do-228 out of the product line of the Skyservant itself, according to "the concept that the Dornier 128-228 family is based on extensive standardization of the various models, with identical fuselage sections and cabin layouts adaptable to various types of mission." For the larger commuter, or what is today called the "30-seater," the chart for development of the Dornier family suggests another name, "LTA Project."

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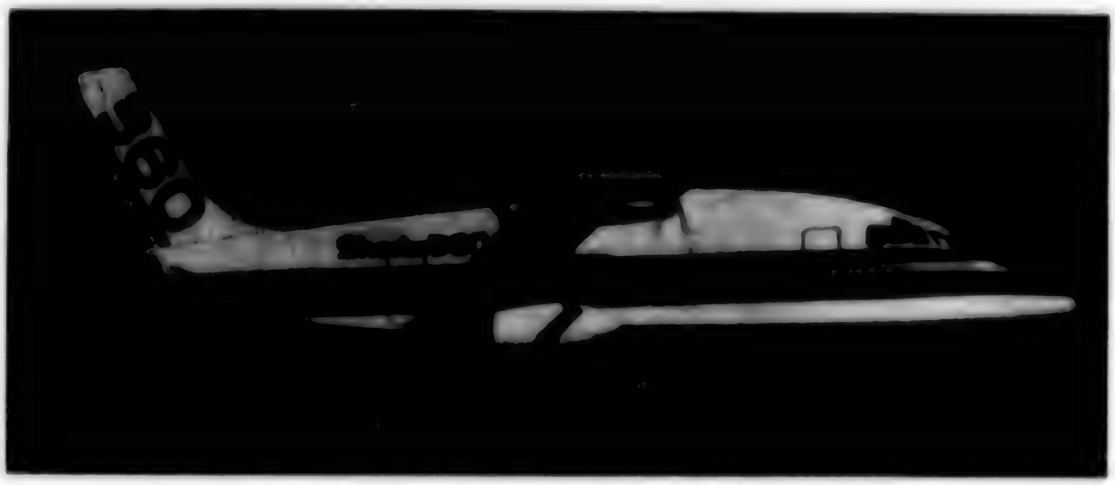
PRODUCTION OF NEW FEEDERLINER ANNOUNCED

Gelsenkirchen AEROKURIER in German Aug 80 p 926

[Text]



At press conferences in London and Washington, Short Brothers Ltd of Northern Ireland announced a new 36-seat feederliner, which should be available before the end of 1982. Derived from the 30-seat Short 330, which is currently in service with the German DLT airline among others, the 360 differs principally in having a longer fuselage. Like the 330, the 360 will be powered by PT6 engines, of which more than 18,000 are in service world-wide. Short estimates the market potential in the 360 class at more than 10,000 units by the end of the 1980s. Further details about the 360 will be released at the Farnborough Air Show.

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TRANSPORTATION

GOVERNMENT-SPONSORED DEVELOPMENT OF 'UNI-CAR' CONTINUES

Munich SUEDDEUTSCHE ZEITUNG in German 15 Oct 80 p 44

[Article: "The Car of the Future Is Making Quiet Progress"]

[Text] Darmstadt--The car of the future makes less noise, protects pedestrians and occupants much better in an accident and uses less fuel than current passenger cars. Currently a team from the Technical Universities in Aachen, Berlin, Stuttgart and Dramstadt is demonstrating what can be achieved in the short term with known technology concerning automobile safety, environmental protection and economy with the construction of its medium-size research vehicle Uni-Car: it will reach a speed of at least 170 km/h, consumes only 6.7 liters of diesel fuel per 100 km, in spite of its high weight of 1,250 kg and an automatic transmission, offers a good chance of survival to pedestrians in collisions at speeds up to 45 km/h and to its occupants in crashes up to 60 km/h, and has no equal for quietness.

The vehicle has been built in less than 4 years at the 4 universities under the terms of a competition announced by the Ministry for Research; six prototypes will be ready in less than a year. Prof Bert Breuer of the Department of Vehicle Technology at the Darmstadt Technical University, who is heading the project, explained how the 30 members of the group achieved the best performance from their design. First of all, they had to make the vehicle's skin as slippery to the wind as possible. A special station wagen shape was selected which, in contrast to traditional cars, has a smoothly enclosed underside. The associated problems of engine cooling are solved by taking the air, which enters at the plastic front end, in a tunnel next to the exhaust through the passenger compartment to the rear and through slots located ahead of the side doors. The result is about 40 percent less wind resistance compared with most contemporary mid-size cars.

The vehicle researches chose a direct-injection turbo-diesel engine as the power plant; it has four cylinders, a capacity of 2.5 liters, an output of 100 hp (74 KW) and will be built by M. A. N. to the universities' design. "We took the turbodiesel because it offers the best way to use fuel known today," Breuer stressed. The engine is electronically controlled to operate at the lowest possiblerrate of fuel consumption.

According to Breuer, one of the most important goals in the construction of the Uni-Car was a high measure of safety for the occupants and pedestrians involved in an accident. Consequently the front end of the car does not have a bumper, but is made of a 20-centimeter thick layer of compliant artificial foam. The hood and front fenders are also covered with this foam, which reduces the risk of injury in an accident, as do the springmounted windshield and the padded roof frame.

Bonn has given the universities a grant of DM 35 million for the development of the Uni-Car, which far exceeds the specifications laid down by the Ministry for Research. In the German automobile industry, which is participating in the competition with three studies and which initially regarded the universities' project with some suspicion, development costs for a new production model can approach DM 1 billion.

Prof Breuer has no answer to the cardinal question: what would the car of the future cost in mass production? He is unwilling to venture a cost estimate, because he knows that this design will never go into production in this form: "We will be satisfied if as many of our ideas as possible turn up somewhere in automobile production." The most important goal of the universities, training qualified engineers for automobile design, would be achieved with the construction of the Uni-Car.

9581
CSO: 3102

FLUIDIZED-BED COMBUSTION TESTED FOR SHIPS' BOILERS

Stockholm NY TEKNIK in Swedish 28 Aug 80 p 14

[Article by Hans Werner]

[Text] The fluidized beds are ready to go to sea. That type of boiler makes it possible to burn the worst bunker oil and coal in turbine-driven ships. Stal-Laval, which developed the technology for a new ship's engine--with tests at the Orebro thermal powerplant, among other places--is looking for interested shipowners.

Civil engineer Per Erik Larsson says, "We cannot get any further now in a laboratory setting. We need to go out in a ship to show what the system is capable of."

The fluidized bed makes higher steam temperatures and the use of cheaper fuels possible. Those are two basic conditions for low fuel consumption and good energy economy.

Ships of the Future Will Bunker Sand

The principle behind fluidized-bed combustion involves good heat transfer and an even distribution of temperature. This results in small dimensions and limited amounts of heat-resistant material.

The bed's temperature is about 850°C with a steam temperature of 600°C. This should be compared to traditional marine boiler engineering, in which the flue gas temperature reaches from 1150 to 1200°C and the steam produced is within a range of 510 to 535°.

The temperature of the material in the bed stands at only 50 to 75°C over that of the steam. The risk of high-temperature corrosion is reduced despite the high steam temperature. Ash and sand bind the corrosion-promoting vanadium. It is removed from the process together with the sand, which must be drawn off at regular intervals.

Baffle on Test Bed

The ship of the future must therefore bunker sand. A 20-MW engine needs from 35 to 40 cubic meters of sand for a trip between the Persian Gulf and Europe. Used in the bed is silica sand with a grain size of between 0.5 and about 2 mm.

Development of the fluidized-bed process at Stal-Laval has concentrated chiefly on the burning of heavy oil. When the oil refineries are forced to squeeze more products out of their oil, the lower-quality oil will remain for the shipowners to propel their ships with. The tests in Finspang involved studies of combustion methods, material properties, corrosion, erosion, and component development (nozzles, automatic control devices, monitoring equipment, and so on).

With a bed on a cradle, the ship's movements at sea were simulated in order to test the baffle or equivalent devices for controlling the movements of the bed mass. It performs like a fluid, since it is held suspended by the input of combustion air. The input nozzles for oil and air have been designed so that replacements can be made while in operation.

Coal Returns to Ships

In Orebro a full-scale fluidized-bed unit was tested at the municipal powerplant. The tests in 1978 and this year each comprised 1,000 hours. (Data for the test bed and a 20-MW turbine engine are shown in the table.)

Results of Stal-Laval's Orebro Tests on Fluidized-Bed Combustion

		Superheater	Intermediate superheater	Test rig
Steam output	MW	4.1	5.9	1.5
Fuel output	MW	16.4		2.6
Steam flow	Kg/s	15.5	13.7	8.9
Steam in	°C	498	412	530
Steam out	°C	602	602	602
Steam pressure	MPa	13	3	12
"	bar	129	31	122
Bed temperature	°C	850		850
Bed velocity	m/s	2		1.9
Bed area	m^2	11.2		1.79

The fluidized-bed unit is used as a supplemental superheater and intermediate superheater in Stal-Laval's new engine. This covers an output range of 10 to 33 MW. Steam admission data: 10-14 MPa (101-141 bar), 600°C superheating, and 600°C intermediate superheating.

Coal is a simpler fuel for fluidized beds. This is evident from the fact that no inert material such as sand needs to be supplied. It is also easy to feed coal to the beds in comparison with oil. Unlike conventional stoker boilers, the bed is not sensitive to variations in the coal's quality and composition.

Shipping: a Cautious Industry

Development will continue toward a boiler installation based entirely on the fluidized-bed principle, say Stal-Laval's engineers. Such boilers are not expected to come into use until experience has been gained with superheater and intermediate superheater beds.

What is causing the delay?

Shipping is a conservative and cautious industry.

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TRANSPORTATION

BRIEFS

CURRENT AIRBUS SALES FIGURES--on 27 June of this year an agreement for the sale of six A3100-200s was signed by Kuwait Airways and Airbus Industries. Kuwait Airways is thus the first Middle Eastern airline to decide for the "small Airbus." The first A310 is to be put into service by Kuwait Airways in the fall of 1983. The A310 will replace the airline's Boeing 707s on internal routes as well as on those to Europe and the Far East. Including the order from Kuwait Airways, the number of aircraft sold by Airbus Industries totals 415, with 267 firm orders and 148 options. Of these 196 are firm orders and 80 options for the A300. Orders for the smaller A310 are divided into 71 firm orders and 68 options. [Text] [Gelsenkirchen AEROKURIER in German Aug 80 p 926] 9581

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